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Irrigation Estimation from Soil Water Balance and the Water Cloud Model by leveraging Sentinel-1 and Sentinel-2 observations

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Irrigation plays a pivotal role in the hydrological cycle, representing about 70% of freshwater withdrawals. However, its representation in Earth System models is characterized by significant uncertainties in terms of amount, timing and spatial distribution. Earth Observation data offer a viable way to reduce this uncertainty thanks to their ability to sense the soil and vegetation in its real condition with few-days revisit timing and high spatial resolution (~ 10 m), e.g. with the new Sentinel missions.

In this contribution, we use remote sensing observations from the Sentinel-1 and Sentinel-2 satellite missions to constrain a simple Soil Water Balance (SWB) model coupled with the semi-empirical Water Cloud Model (WCM) and obtain irrigation estimates via an inverse modelling solution. The WCM, which is a model simulating backscatter observations (σ^0) from soil moisture and a vegetation descriptor, is forced by vegetation indexes from Sentinel-2 data and soil moisture simulated by the SWB that includes a sprinkler irrigation scheme. The model outputs are then matched with Sentinel-1 observations to obtain irrigation estimates.

The model is tested over an irrigated field of the Po River valley, one of the most intensively European irrigated areas. Results show that the model can capture the irrigation signal with relatively good accuracy. It also provides an estimate of soil moisture in the field. Nonetheless the revisit time of the satellite platforms and the simplicity of backscatter model, especially in the representation of the vegetation component, constitute two main limitations of the model. This model is a viable tool that can be easily applied in the context of precision agriculture to optimize irrigation practices and conserve water resources even when in-situ soil moisture and irrigation measurements are not available.